

Relationship between Satellite-Derived Snow Cover and Snowmelt-Runoff Timing and
Stream Power in the Wind River Range, Wyoming

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Abstract

Earlier onset of springtime weather including earlier snowmelt has been documented in the western United States over at least the last 50 years. Because the majority (>70%) of the water supply in the western U.S. comes from snowmelt, analysis of the declining spring snowpack (and shrinking glaciers) has important implications for streamflow management. The amount of water in a snowpack influences stream discharge which can also influence erosion and sediment transport by changing stream power, or the rate at which a stream can do work such as move sediment and erode the stream bed. The focus of this work is the Wind River Range (WRR) in west-central Wyoming. Ten years of Moderate-Resolution Imaging Spectroradiometer (MODIS) snow-cover, cloud-gap-filled (CGF) map products and 30 years of discharge and meteorological station

data are studied. Streamflow data from six streams in the WRR drainage basins show lower annual discharge and earlier snowmelt in the decade of the 2000s than in the previous three decades, though no trend of either lower streamflow or earlier snowmelt was observed using MODIS snow-cover maps *within* the decade of the 2000s. Results show a statistically-significant trend at the 95% confidence level (or higher) of increasing weekly maximum air temperature (for three out of the five meteorological stations studied) in the decade of the 1970s, and also for the 40-year study period. MODIS-derived snow cover (percent of basin covered) measured on 30 April explains over 89% of the variance in discharge for maximum monthly streamflow in the decade of the 2000s using Spearman rank correlation analysis. We also investigated stream power for Bull Lake Creek Above Bull Lake from 1970 to 2009; a statistically-significant trend toward reduced stream power was found (significant at the 90% confidence level). Observed changes in streamflow and stream power may be related to increasing weekly maximum air temperature measured during the 40-year study period. The strong relationship between percent of basin covered and streamflow indicates that MODIS data is useful for predicting streamflow, leading to improved reservoir management.